IMPLEMENTING SMART WITHIN PEO, TACTICAL MISSILES

Robert B. Perry, Ann H. Kissell, and Charles F. Bates

Introduction

Constraints on funding Army acquisition programs combined with the increased demand for Army systems is an all too common occurrence. Fortunately, however, modeling and simulation (M&S) technology is helping the Army acquisition community deal with this dilemma. In particular, the Program Executive Office, Tactical Missiles (PEO, TM) has been a major proponent in using M&S technology and has embraced the Simulation and Modeling for Acquisition, Requirements and Training (SMART) concept.

The Javelin Project Office, which reports to the PEO, TM, has recognized the impact of the SMART concept by incorporating it into the Javelin Simulation Program. By applying M&S throughout the Javelin missile system's acquisition life cycle, the project office has ensured that the required M&S resources and support are available for its government/industry support team to successfully complete acquisition decisions, system improvements, and user training. Specifically, the Javelin Simulation Program has allowed the project office to enhance system performance while simultaneously reducing program costs by reducing the number of flight tests necessary to demonstrate system capabilities.

To achieve the full benefit of the SMART concept, M&S technology must be reused. For example, the Tube-launched, Optically-tracked, Wire-guided Fire and Forget (TOW F&F) missile system, managed by the Close Combat Anti-Armor Weapon Systems (CCAWS) Project Office, has benefited from M&S techniques developed for the Javelin Simulation Program. In addition, the TOW F&F missile will benefit from this process when its own M&S suite is developed. To gain further benefit of the SMART concept, the Javelin Simulation Program can reuse tools developed for the TOW F&F Program in its own product improvement efforts.

System Description

The Javelin missile system is a medium-range, man-portable, shoulder-launched, fire-and-forget, anti-armor weapon system. It has two major components: a reusable Command Launch Unit (CLU) and a missile sealed in a disposable launch-tube assembly. The CLU incorporates an integrated day/night sight and provides target engagement capability in adverse weather and countermeasure environments.
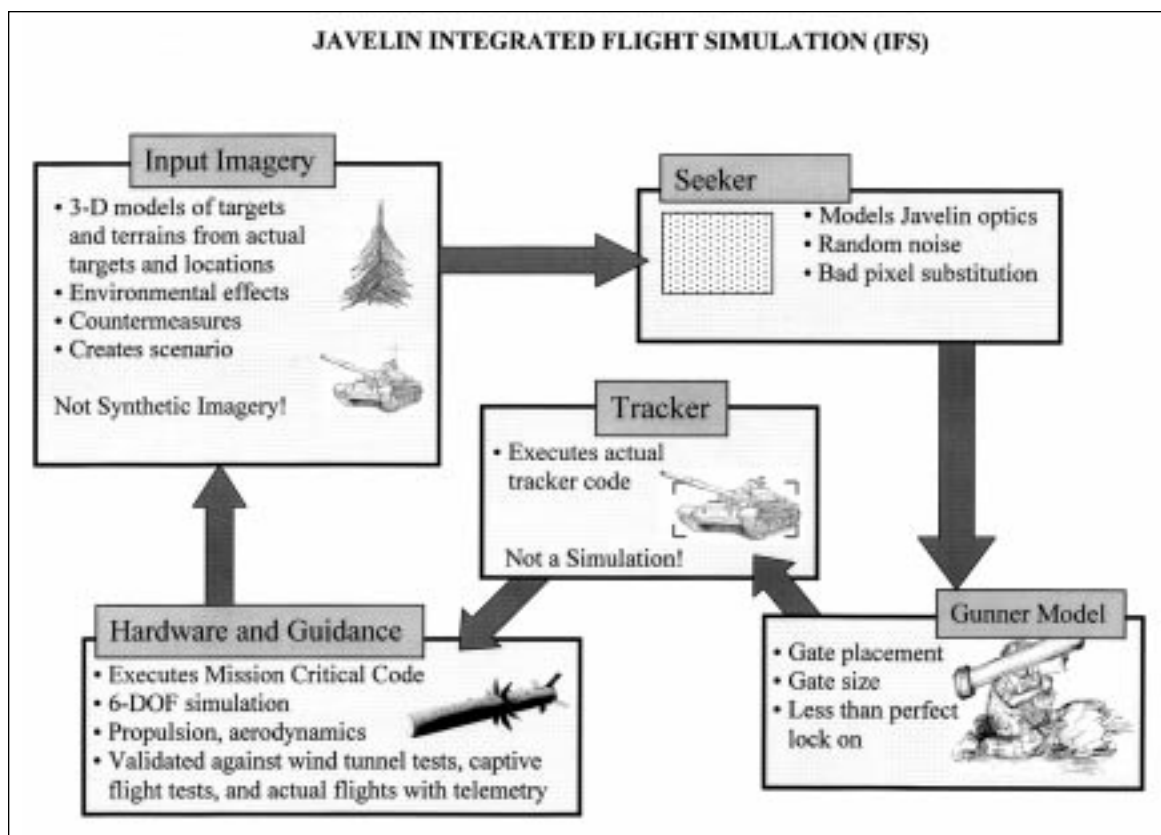
Javelin uses fire-and-forget technology that allows the gunner to fire the missile and immediately take cover or reload. The onboard tracker guides the missile to the target until impact. This tracker, and its ability to stay locked on the target throughout flight, emerged as the most critical aspect of the Javelin system. A cost-effective way to develop and test new tracker algorithms became a necessity. Additionally, an innovative way to determine system performance of a fire-and-forget imaging infrared system was needed. From these requirements, the Javelin Simulation Program evolved.

Initial Activities

The Javelin Project Office undertook a comprehensive program for managing key system, subsystem, and component-level models and simulations, related databases, and test data. These models and simulations evolved from initial all-digital simulations supporting requirements analysis, and they have continued to support the program throughout its development life cycle. The primary simulation developed to represent the Javelin system was the Javelin Integrated Flight Simulation (Javelin IFS).

The Javelin IFS is a high-fidelity, all-digital simulation whose primary functions are tracker algorithm development, flight test predictions and reconstructions, and system-performance assessment. The Javelin IFS contains an environment model, a seeker model, a tracker model, a six degree-of-freedom (6-DOF) model, and a gunner model.

JAVELIN INTEGRATED FLIGHT SIMULATION (IFS)

Input Imagery
- 3-D models of targets and terrains from actual targets and locations
- Environmental effects
- Countermeasures
- Creates scenario

Not Synthetic Imagery!

Seeker
- Models Javelin optics
- Random noise
- Bad pixel substitution

Tracker
- Executes actual tracker code

Not a Simulation!

Hardware and Guidance
- Executes Mission Critical Code
- 6-DOF simulation
- Propulsion, aerodynamics
- Validated against wind tunnel tests, captive flight tests, and actual flights with telemetry

Gunner Model
- Gate placement
- Gate size
- Less than perfect lock on

Javelin's prime contractor and the U.S. Army's Aviation and Missile Research, Development and Engineering Center (AMRDEC) developed the Javelin IFS jointly during engineering and manufacturing development (EMD). Verification, validation, and accreditation (VV&A) of the Javelin IFS was performed by AMRDEC and accreditation by the Army Materiel Systems Analysis Activity (AMSAA).

Using the validated Javelin IFS, developers did a simulation-based system performance assessment to support the production acquisition decision. Using the Javelin IFS, developers also devised a suite of scenarios to measure the performance of the system, which included probability of hit, probability of kill, and intercept geometries. The performance assessment included more than 70,000 simulation trials, and the results were analyzed to determine

whether the Javelin system met its requirements. These simulation results were provided to AMSAA for its independent analysis. The simulation results were implemented into various force effectiveness simulations to support Army-level studies.

Current SMART Activities

As the Javelin Program has matured, so has the Javelin Simulation Program. Recent simulation activities have illustrated how the Javelin Program has embraced the Army's SMART concept. The Javelin Project Office established the Javelin Simulation Center (JSC) at AMRDEC with the Javelin IFS as the backbone of the simulation capabilities. The JSC resulted from a Javelin Project Office decision to establish a capability at AMRDEC for software development, simulation, assessment, and demonstration activities.

The JSC combines AMRDEC organizations and the Redstone Technical Test Center (RTTC), part of the U.S. Army Test and Evaluation Command (ATEC), in a teaming environment via an integrated fiber-optic network. This allows for tracker algorithm development, tactical software coding and testing, simulation-based performance assessment, and hardware testing in an integrated environment. The Javelin system hardware contained in the JSC is maintained by RTTC. The JSC allows the Javelin Project Office, for the first time ever, to share information with the simulation and test communities.

TOW F&F System Description

The TOW F&F system will provide a long-range, lethal, anti-armor capability for light forces currently equipped with the Improved Target Acquisition System (ITAS). The TOW F&F missile requires a fire-and-forget

primary mode of operation with an alternate mode as backup; increased range, lethality, and platform survivability; compatibility with the ITAS platform through use of a platform appliqué; and the ability to maintain ITAS platform capability to fire existing TOW missiles without performance degradation. The TOW F&F system was approved for System Development and Demonstration (SDD) (formerly known as EMD) in third quarter FY00, and a contract was awarded in fourth quarter FY00.

TOW F&F SMART Strategy

The TOW F&F Program acquisition strategy emphasizes the use of M&S to reduce schedule, cost, and performance risk. Previous M&S efforts on Javelin, as well as on other Army systems, have benefited the TOW F&F Program as a result of state-of-the-art simulation components and technologies. These capabilities allow more simulated component and system design and testing, thus reducing overall schedule risk associated with these functions.

These capabilities will lower cost risk by reducing the number of test missiles from 170 rounds needed for Javelin development to approximately 43 rounds needed for TOW F&F SDD flight testing. This reduction still allows all critical operational issues and criteria and key performance parameters to be addressed. This is possible because M&S permits performance assessment in simulation environments prior to live firing. This will allow destructive live-testing efforts to focus on reliability and performance issues related only to the live-fire environment.

The TOW F&F Program employs a suite of M&S tools that encompass all three M&S environments: live, virtual, and constructive. Additionally, Javelin simulation methodology, as well as synthetic targets and back-

grounds developed during the Javelin development effort, will be used during TOW F&F development. The prime contractor will develop a TOW F&F IFS, which will consist of a 6-DOF model, system reliability estimates, and an Automatic-target Tracker Simulation (ATS). The ATS consists of automatic target tracking algorithms, a seeker model, and a synthetic scene generator. The ATS will be used to support the early analysis of TOW F&F autotracker and terminal homing guidance design.

Verification of TOW F&F IFS models will be conducted to ensure the execution of proper modeling techniques and structure as well as to ensure that the algorithms are implemented correctly. The validation of the TOW F&F IFS will be accomplished by comparing the system flight test data with post-flight reconstruction data and with the pre-flight statistical performance boundaries. The CCAWS Project Office will be the verification and validation proponent for the TOW F&F IFS, and ATEC will be the accreditation authority.

In addition to the all-digital TOW F&F IFS, a Virtual Prototype Simulator (VPS) will be used. The VPS is currently being updated with the real-time 6-DOF and the contractor's design concept for use in the project office's early user involvement. Soldiers from the U.S. Army Infantry Center will conduct simulated engagements using combat developer-approved scenarios.

CSF

The TOW F&F Common Simulation Framework (CSF) provides an object-oriented simulation model that allows TOW F&F components to be placed into simulations in a user-friendly environment. The commonality between these simulations will greatly streamline the VV&A process

for TOW F&F. The CSF is also being considered as the simulation model for the next-generation Javelin IFS that will allow the TOW F&F Simulation Program to feed back to the Javelin Program leading-edge M&S technology.

Summary

The PEO, TM has used M&S technology in its various programs for many years and has supported SMART from its inception. Two examples of this are the M&S activities integrated into the Javelin and TOW F&F programs. Employing SMART has allowed both programs to demonstrate system capabilities in a resource-constrained acquisition environment.

ROBERT B. PERRY is assigned to the PEO, TM. He supports system-level software, M&S, and analysis activities for a variety of systems. He holds a B.S. in electrical engineering from Tennessee Technological University and an M.S. in systems management from Florida Institute of Technology.

ANN H. KISSELL is the Simulation Group Lead for the CCAWS Project Office. She holds an M.S.E. in systems engineering from the University of Alabama in Huntsville, AL, and B.S. degrees in engineering physics and physics from Christian Brothers University.

CHARLES F. BATES is the Lead Engineer for the Javelin IFS in the Systems Simulation and Development Directorate, AMRDEC. He holds a B.S. in electrical engineering from the University of Alabama in Tuscaloosa.